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A white dwarf with a low magnetic field in the IP RXJ0028.8+5917/V709Cas

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Abstract. We report the first detailed spectroscopic observations of the recently identified intermediate polar RXJ0028.8+5917/V709 Cas. We discovered that the system shows significant EW ∼(2-4)Å broad absorptions affecting the Balmer lines from Hδ to Hβ. These broad absorptions are interpreted as the contribution of an underlying DA log g=8 white dwarf at a temperature of ∼23 000 K, contributing ∼17 % (at 4500 Å) to the overall flux. This is the first direct detection of a white dwarf in an intermediate polar system. The absence of significant Zeeman splitting indicates a magnetic field lower than 10 MG, confirming that, at least in some cases, intermediate polars have weaker fields than polars.

1. Introduction

The X-ray source RXJ0028.8+5917 was discovered by ROSAT as an Intermediate Polar with a 312 sec X-ray pulsation and was identified with a m_v=14 variable star V709 Cas (Haberl & Motch 1995, Motch et al. 1996). It was also extensively observed with the BeppoSAX satellite (de Martino et al., this conference). Observations of RXJ0028.8+5917/V709 Cas were performed at the 1.93m telescope of the Haute-Provence Observatory (OHP, France) during 4 nights on Aug. 1998. 43 spectra with 7 Å resolution and 15 or 20 min exposures were obtained in the range (3600-7200Å). The optical spectrum is typical of IPs with strong H and He emission lines. Radial velocities on the 4 nights were used to determine the best orbital ephemeris of the blue-to-red crossing time as : To = HJD 2451048.0575(2) + E*0.2225(2) d (or P = (5.341 ± 0.005) h). This removes the previous uncertainty between different aliases.

2. A two-component spectrum

The mean optical spectrum of V709 Cas also shows clear broad absorptions features in the Balmer lines, Hδ, Hγ and Hβ, while such a feature is absent

around HeII (see Bonnet-Bidaud et al. 2001, for the figures). Such absorption lines were not yet seen in any other IPs. Lines in absorption are sometimes seen among classical CVs, mainly in nova-like systems in high states and during dwarf nova eruptions, which suggests that they are formed in an optically thick disk with a high mass transfer (see for instance La Dous 1994, Hessman 1986). In the case of V709 Cas, the stability of the optical flux excludes a dwarf nova event and the absence of He absorptions does not favour a disk origin. The absorptions are interpreted as coming from the white dwarf atmopshere. The line FWHMs have been compared to a grid of white dwarf models (Koester 2000) and the line EWs have been used to determine the white dwarf contribution to the overall flux. The range of values of the measured FWHM absorptions (51-65 Å) is found consistent with a $\log g$=8.0 white dwarf at a temperature of (18 000 - 30 000 K) with a best value at T = 23 000 K. The white dwarf is found to contribute ∼17% at 4500Å and only ∼6% at 6500Å. The comparison of the measured to theoretical flux values yields a Rwd(10^9cm/D(pc)) value of (0.35-0.42), corresponding to a distance D=(210-250pc), for the (18 000-30 000K) temperature range (see Bonnet-Bidaud et al. 2001 for details).

3. Discussion

What is the magnetic field value in V709 Cas ? Absorption lines are commonly seen in polars during low states where they are split by the Zeeman effect of a (10-30MG) strong magnetic field. The absence of Zeeman splitting in V709 Cas indicates a low magnetic field. Comparaison has been made with synthetic profiles for B in the range (3-30)MG (see Bonnet-Bidaud et al. 2000). The absence of the Hβ components at 4832Å and 4896Å imposes B $\leq$ 3 MG. This is the first direct evidence of a low magnetic field, at least in some IPs.
Why is the white dwarf visible in V709 Cas ? V709 Cas is the only IP where the WD contribution is significant. The white dwarf characteristics are not atypical among CVs. A high (WD/overall) flux ratio may be reached if the contribution from other regions is significantly lower than in other IPs. This could be the case if the accretion disk is seen at high inclination. Additional observations are clearly needed to see if the visibility of the white dwarf may also depend on the overall accretion rate and luminosity of the source.

4. References

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